# Options Markets:
# Introduction

Chapter 20

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## Option Contracts

- **call option** = contract that gives the holder the right to *purchase* an asset at a specified price, on or before a certain date
- **put option** = contract that gives the holder the right to *sell* an asset at a specified price, on or before a certain date
- key feature: the holder is *not* required to exercise the option, but can *choose* to do so or not ➔ the holder has to pay for this right
- the holder has a *long* position in the option, the seller of the option has the *short* position

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## Key Elements of Options

- *exercise* (*strike*) *price* = the price at which the asset is traded when the option is exercised
- *expiration date* = the last date the option can be exercised on
- *premium* = purchase price of option (paid when the option is purchased, regardless of whether the option is exercised or not)
- *writer* = person initially selling the option
- *American option* = the holder can exercise the option any time *on or before* the expiration date
- *European option* = the holder can exercise the option *only* on the expiration date

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## "Moneyness"

- *in the money* = the option is worth exercising
- *out the money* = the option is not worth exercising
- *at the money* = the holder is indifferent between exercising the option or not
- the moneyness of an option is given by the relationship between the exercise price and the current price of the stock and the type of option
- moneyness is not related to *positive* profits, but to whether the option is exercised or not

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## Underlying Assets

- stock options are the common options
- *index options* = options based on the value of an index ➔ the execution is done by cash settlement
- *futures options* = the holder has the right to buy or sell a specified futures contract, with the price of the futures as exercise price
- *foreign currency options* = the holder can buy or sell a certain sum of foreign currency for a certain sum of domestic currency
- *interest rate options* = options based on debt securities

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## Call Options

- Value at expiration (payoff)
  - a call option will be executed only if the exercise price is lower than the ongoing price of the stock
  - hence, the value of the option at expiration is

    $$\text{Payoff to call holder} = \begin{cases} S_T - X, & \text{if } S_T > X \\ 0, & \text{if } S_T \le X \end{cases}$$

    where $S_T$ is the "current price" of the stock, and $X$ is the exercise price

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# Call Options (cont.)

- Moneyness
  - a call option is
    - *in the money* – if the exercise price is below the current price
    - *out the money* – if the exercise price is above the current price
    - *at the money* – if the exercise price is equal to the current price

# Call Options (cont.)

- Profits
  - for the holder of the call option, the net profit is

    Profit = Value at expiration – Premium ($C$)

  - notice that the holder might not get positive profit even if the option is exercised
  - for the writer of the call option, the value at expiration and net profit are exactly the opposite those of the holder

    Profit of writer = – Profit of holder

  - writing a *naked call* (i.e., a call option without an offsetting position in the stock) exposes the investor to unlimited losses if stock price rises
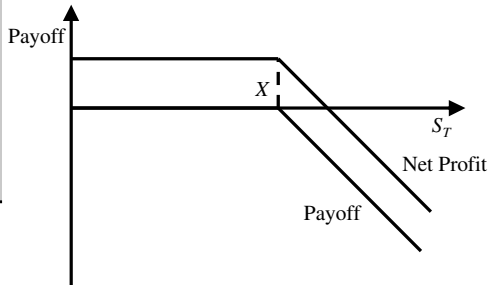
# Call Options – Holder



Payoff

Payoff = Value at expiration

Net Profit

$C$ { $X$ $S_T$
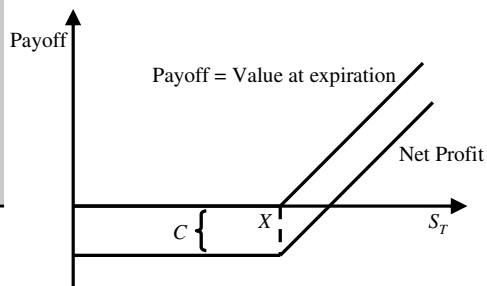
## Call Options – Writer

Payoff

X

$S_T$

Net Profit

Payoff

## Call Options – Example

- strike price: $X = \$100$
- premium: $15

| Value of stock ($S_T$) | Payoff | Profit for holder | Profit for writer |
|---|---|---|---|
| $90 | $0 | –$15 | $15 |
| $100 | $0 | –$15 | $15 |
| $110 | $10 | –$5 | $5 |
| $120 | $20 | $5 | –$5 |

## Put Options

- Value at expiration (payoff)
  - a put option will be executed only if the exercise price is higher than the ongoing price of the stock
  - hence, the value of the option at expiration is

$$\text{Payoff to put holder} = \begin{cases} 0, & \text{if } S_T > X \\ X - S_T, & \text{if } S_T \leq X \end{cases}$$

    where $S_T$ is the "current price" of the stock, and $X$ is the exercise price

## Put Options (cont.)

- Moneyness
  - a put option is
    - *in the money* – if the exercise price is above the current price
    - *out the money* – if the exercise price is below the current price
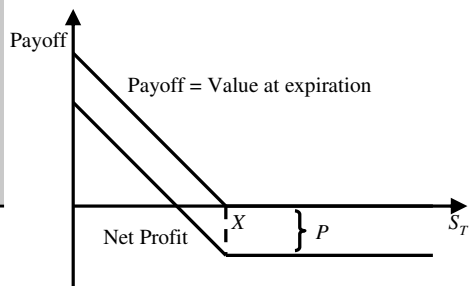    - *at the money* – if the exercise price is equal to the current price

## Put Options (cont.)

- Profits
  - for the holder of the put option, the net profit is

    Profit = Value at expiration – Premium (*P*)
  - for the writer of the put option, the value at expiration and net profit are exactly the opposite those of the holder

    Profit of writer = – Profit of holder
  - writing a *naked put* (i.e., a put option without an offsetting short position in the stock) exposes the investor to losses if the stock price falls
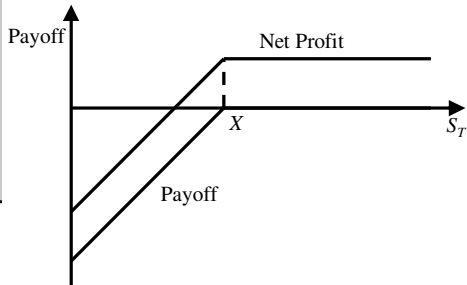
## Put Options – Holder



Payoff

Payoff = Value at expiration

Net Profit

$X$

$P$

$S_T$

## Put Options – Writer

Payoff

Net Profit

$X$

$S_T$

Payoff

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## Put Options – Example

- strike price: $X = \$100$
- premium: $15

| Value of stock ($S_T$) | Payoff | Profit for holder | Profit for writer |
|---|---|---|---|
| $80 | $20 | $5 | –$5 |
| $90 | $10 | –$5 | $5 |
| $100 | $0 | –$15 | $15 |
| $110 | $0 | –$15 | $15 |

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## Investments in Options

- purchasing call options or writing put options are *bullish* strategies (i.e., provide profits when stock prices increase)
- writing call options or purchasing put options are *bearish* strategies (i.e., provide profits when stock prices fall)
- as opposed to stock investments, investments in options provide better hedging opportunities
- also, remember that quotations and information about options are given *per share*, but an option contract is usually written for 100 shares
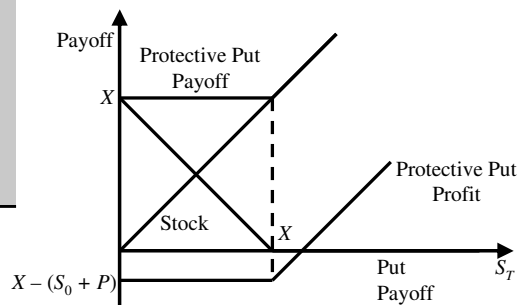
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# Option Strategies

- Protective Put
  - buy a stock and a put option on the stock at the same time
  - used to limit loss to a certain level (portfolio insurance) ➔ used for *risk management*
  - value of protective put at expiration:

|  | $S_T \leq X$ | $S_T > X$ |
|---|---|---|
| Payoff of stock | $S_T$ | $S_T$ |
| Payoff of put | $X - S_T$ | $0$ |
| *Total payoff* | $X$ | $S_T$ |

# Protective Put – Profit of Holder



Payoff

$X$

Protective Put Payoff

Stock

$X$

Protective Put Profit

$X - (S_0 + P)$
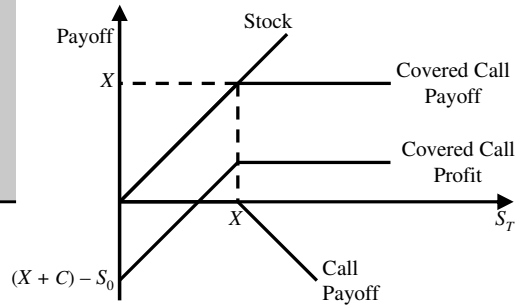
Put Payoff

$S_T$

# Option Strategies (cont.)

- Covered Call
  - buy a stock and sell a call option on the stock at the same time
  - used for downside protection, at the expense of giving up gain potential
  - value of protective put at expiration:

|  | $S_T \leq X$ | $S_T > X$ |
|---|---|---|
| Payoff of stock | $S_T$ | $S_T$ |
| Payoff of call | $0$ | $-(S_T - X)$ |
| *Total payoff* | $S_T$ | $X$ |

## Covered Call – Profit of Holder



Payoff — Stock — Covered Call Payoff — Covered Call Profit — $X$ — $X$ — $S_T$ — $(X + C) - S_0$ — Call Payoff
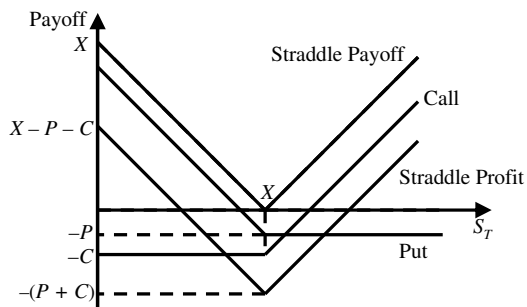
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## Option Strategies (cont.)

- Straddle
  - buy a call and a put option on the same stock, with same exercise price and same expiration date
  - used if price is believed to change, but direction of change is unknown (bet on volatility)
  - value of straddle at expiration:

|  | $S_T \leq X$ | $S_T > X$ |
|---|---|---|
| Payoff of call | 0 | $S_T - X$ |
| Payoff of put | $-(S_T - X)$ | 0 |
| *Total payoff* | $X - S_T$ | $S_T - X$ |

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## Straddle – Profit of Holder



Payoff — $X$ — Straddle Payoff — Call — $X - P - C$ — Straddle Profit — $X$ — $S_T$ — $-P$ — $-C$ — Put — $-(P + C)$

## Option Strategies (cont.)

- Spreads
  - combinations of two or more call options (or put options) on the same stock, with different exercise prices or expiration dates
  - *money spread* = difference between options is exercise price
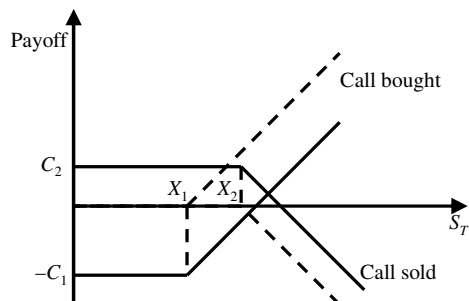  - *time spread* = difference between options is expiration date

## Example of Spread

- money spread: buy a call option with exercise price $X_1$ and sell a call option with exercise price $X_2 > X_1$
- bullish spread - payoff is either increased or unaffected by stock price increases
- value of spread at maturity:

|  | $S_T \leq X_1$ | $X_1 < S_T \leq X_2$ | $S_T > X_2$ |
|---|---|---|---|
| Payoff of call 1 | 0 | $S_T - X_1$ | $S_T - X_1$ |
| Payoff of call 2 | 0 | 0 | $-(S_T - X_2)$ |
| *Total payoff* | 0 | $S_T - X_1$ | $X_2 - X_1$ |

## Spread – Calls Profits and Payoffs

## Spread – Profit of Holder

Payoff

$X_2 - X_1$ ---- Spread Payoff

Spread Profit

$X_1$

$C_2 - C_1$

$X_2$

$S_T$
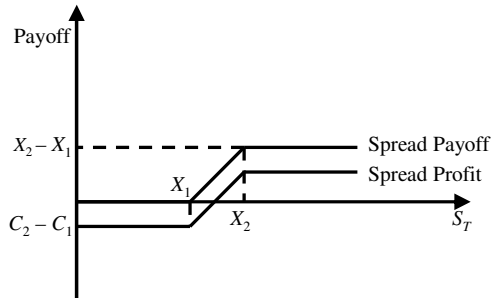
## Option Strategies (cont.)

- Collar
  - options strategy that brackets the value of an existing portfolio between two bounds
  - used if a target wealth is set, and losses need to be limited
  - a lower bound can be placed by buying a put option ➔ need to pay a premium ➔ to recover the money paid for premium, write a call option (with higher exercise price)
  - the protection against downside risk is obtained by giving up the gain potential from price increases
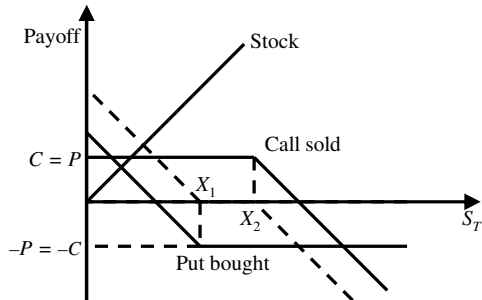
## Example of Collar

- you already hold stock, so buy a put option on the same stock with exercise price $X_1$ and sell a call option with exercise price $X_2 > X_1$
- value of collar at maturity:

|  | $S_T \leq X_1$ | $X_1 < S_T \leq X_2$ | $S_T > X_2$ |
|---|---|---|---|
| Payoff of stock | $S_T$ | $S_T$ | $S_T$ |
| Payoff of put | $X_1 - S_T$ | 0 | 0 |
| Payoff of call | 0 | 0 | $-(S_T - X_2)$ |
| *Total payoff* | $X_1$ | $S_T$ | $X_2$ |

- notice that the payoff and the profit of the holder are equal, since the premiums cancel out
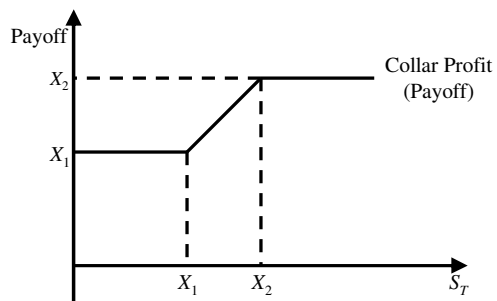
## Collar – Calls Profits and Payoffs



Payoff / Stock / Call sold / $C = P$ / $X_1$ / $X_2$ / $S_T$ / $-P = -C$ / Put bought

## Collar – Profit of Holder



Payoff / $X_2$ / $X_1$ / Collar Profit (Payoff) / $X_1$ / $X_2$ / $S_T$

## Put-Call Parity Relationship

- an alternative strategy that provides the same type of protection as a protective put is a call with same expiration date and strike price $X$ and a riskless bond with face value equal to $X$
- value of investment at maturity:

|  | $S_T \leq X$ | $S_T > X$ |
|---|---|---|
| Payoff of call | 0 | $S_T - X$ |
| Payoff of bond | $X$ | $X$ |
| Total payoff | $X$ | $S_T$ |

- this is exactly the same payoff pattern as the protective put

## Put-Call Parity Relationship (cont.)

- arbitrage argument: if two investments always have the same value, they should have the same price
- the price of the protective put is the sum of put premium and stock price at time 0
- the price of the call + bond investment is the sum of the call premium and the present discounted value of the bond (i.e., of $X$)
- hence,

$$C + \frac{X}{(1 + r_f)^T} = S_0 + P$$

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## Put-Call Parity Relationship (cont.)

- this relationship is called the *put-call parity theorem*
- notice that it applies only to European options, because they are exercised only at maturity
- it can be generalized to include dividends paid on the underlying stock:

$$P = C - S_0 + PV(X) + PV(Dividends)$$

- if it fails – arbitrage opportunity (create the other investment and profit from the price difference)

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## Exotic Options

- *Asian options* = payoff depends on average price of underlying asset during some portion of the life of the option
- *barrier options* = payoff depends not only on price at expiration, but also on whether the price has crossed through some barrier
- *lookback options* = payoffs depend in part on the min or max price during the life of the option
- *currency-translated options* = asset or exercise prices denominated in foreign currency
- *binary options* = payoffs depends on whether the price satisfies a certain condition or not

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